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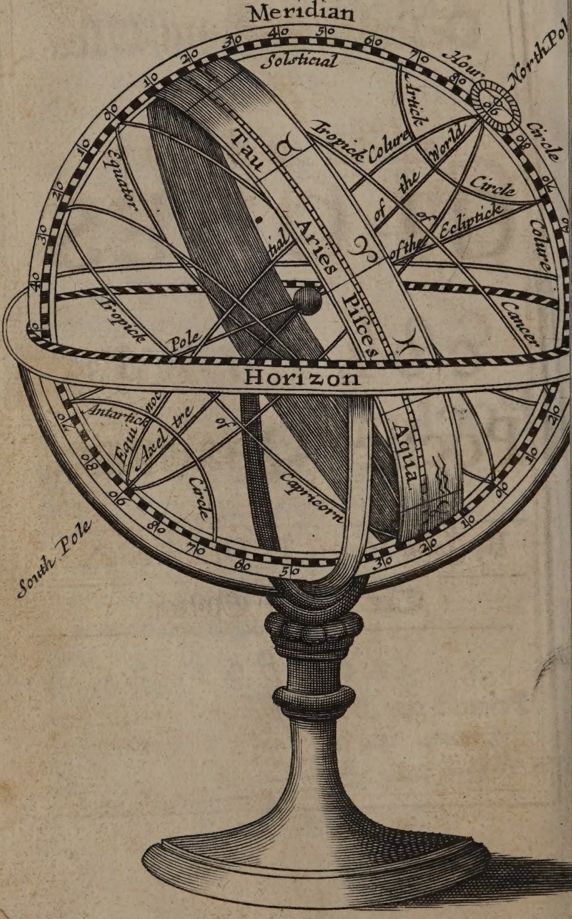
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# THE
# Deſcription and Uſes
# OF THE
# Celeſtial and Terreſtrial
# GLOBES;
# AND OF
# COLLINS's
# Pocket-Quadrant.

By *John Harris*, D. D. and F. R. S.

The Third Edition.

*LONDON:*
Printed for *D. Midwinter*, at the *Three*
*Crowns* in St. *Paul's Church-Yard.*
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## TO THE

# READER.

T*HIS ſhort Account of the* Globe *was Originally deſign'd for the Uſe of ſuch Gentlemen as learn Mathematicks of me at Home. But the Courſe of my Publick Lectures at the* Marine Coffee-Houſe *in* Birchin-Lane, *obliging me to proceed next, to the*

*Doctrine of the* Sphere ; *and the Books on this Subject already publiſhed, being much too large, and filled with Matters very foreign to my Deſign ; I thought it neceſſary to publiſh this* Short Deſcription and Uſe of the Globes, *that my Auditory there may have the Matter in a much ſhorter, and yet I hope in as plain a View : For I know of nothing material that is here omitted.*

# To the READER.

*The* Deſcription and Uſe of Mr. *Collins*'s Quadrant *was occaſion'd by the Requeſt of ſome Perſons who would gladly know the beſt Uſes of it, without being obliged to read over many things which are little to their Purpoſe.*

## The Characters of the 12 Signs of the Zodiack.

| | | | |
|---|---|---|---|
| *Aries* | ♈ | *Libra* | ♎ |
| *Taurus* | ♉ | *Scorpio* | ♏ |
| *Gemini* | ♊ | *Sagittarius* | ♐ |
| *Cancer* | ♋ | *Capricorn* | ♑ |
| *Leo* | ♌ | *Aquarius* | ♒ |
| *Virgo* | ♍ | *Piſces* | ♓ |

## The Characters of the Planets.

| | | | |
|---|---|---|---|
| *Moon* | ☽ | *Mars* | ♂ |
| *Mercury* | ☿ | *Jupiter* | ♃ |
| *Venus* | ♀ | *Saturn* | ♄ |
| *Sun* | ☉ | | |

# THE
# Deſcription and Uſe
# OF THE
# GLOBES.

A GLOBE or SPHERE is a round ſolid Body, every Part of whoſe Surface is equally diſtant from a Point within it, call'd its Centre; and it may be conceived to be form'd by the Revolution of a Semi-circle round its Diameter.

When ſuch a Body as this hath all the Parts of the Earth and Sea drawn or delineated on its Surface, like as in a Map, and placed in their natural Order and Situation, it is called the *Terreſtrial Globe*.

But if on its Surface it hath the fixed Stars and the Images of the Conſtellations drawn, together with the Circles of the Sphere, below deſcribed, 'tis then call'd the *Celeſtial Globe*.

And when the following Circles are ſuppoſed to be deſcribed on the convex Surface of a Sphere, which is hollow within, and after this you imagine all Parts of the Sphere's Surface to be cut away, except thoſe Parts on which ſuch Circles are deſcribed, then that Sphere is call'd an *Armillary Sphere*, becauſe it appears in the form of ſeveral circular Rings, or Bracelets, put together in a due Poſition.

There are ten eminent Circles upon the Globe, or of the Sphere; ſix of which are called *Greater*, and the four other *Leſſer Circles*.

A Great Circle of the Sphere is that, whoſe Plane paſſeth through the Centre of the Sphere, and divides it into two equal Parts or Hemiſpheres.

A Leſſer Circle is that, which is parallel to a Greater ; as the *Tropicks* and *Polar Circles* are to the *Equator*, and as the *Circles of Altitude* are to the Horizon.

Or Leſſer Circles are ſuch as do not divide the Globe into two equal parts.

*The Greater Circles are,*

1. The Horizon, which is a broad Wooden Circle, encompaſſing the Globe round about, having two Notches, the one in the North, the other in the South part of it, for the Brazen Meridian to ſtand in.

There are uſually accounted two Horizons.

Firſt, The *Viſible* or *Senſible*, which you may conceive to be made by ſome great Plane, or the Surface of the Sea; and which divides the Heavens into two *Hemiſpheres*, the one above, the other (apparently) below the Level of the Earth.

This Circle determines the Riſing and the Setting of the Sun, Moon, or Stars, in any particular Latitude; for when any one of them come juſt to the Eaſtern Edge of the Horizon, then we ſay it riſeth; and when it doth ſo at the Weſtern Edge, we ſay it ſetteth. And from hence alſo the *Altitude* of the Sun and Stars is accounted, which is their *Height* in Degrees above the Horizon.

2. The other Horizon is called the *Real* or *Rational*, and is a Circle which encompaſſes the Earth, exactly in the middle, and whoſe Poles are the *Zenith* and *Nadir*; that is, two Points in its Axis, each 90 Degrees

grees diſtant from its Plane, ( as the Poles of all Circles are ) and the one exactly over our Heads, and the other directly under our Feet. This is the Circle which the Wooden Horizon on the Globe repreſents.

On which *Broad Horizon* ſeveral Circles are drawn ; the innermoſt of which is the Number of Degrees of the Twelve Signs of the *Zodiack*, *viz.* 30 to each Sign : For the Ancient Aſtronomers obſerved the Sun in his ( apparent ) Annual Motion, to deſcribe always one and the ſame Line in the Heavens, and never to deviate from this Track or Path to the North or South, as all the other Planets did more or leſs ; and becauſe they found the Sun alſo to ſhift, as it were backward, through all the Parts of this Circle or Path, ſo that in his whole Year's Courſe he would *riſe*, *culminate*, and *ſet* with every Point of it ; they diſtinguiſhed the fixed Stars that appeared in or near this Circle into twelve Conſtellations or Diviſions, which they called Signs ; and becauſe they were moſt of them uſually drawn in the Form of Animals, they called this Circle by the Name of the *Zodiack*, and the very middle Line of it the *Ecliptick*: And ſince every Circle was divided into 360 Parts or Degrees, a twelfth Part of that Number muſt be 30, the Degrees in each Sign.

Next to this you have the Names of thoſe Signs ; next to this the Days of the Month, according to the *Julian Account*, or *Old Stile*, with the *Calendar* ; and then another *Calendar*, according to the *Foreign Account*, called the *New Stile*.

And within theſe is a Circle divided into thirty two equal Parts, which make the thirty two Rhumbs or Points of the Mariner's Compaſs, with the firſt Letters of the Names annexed; and ſince that one 32th part of 360 Degrees is 11 Degrees 15 Minutes, they account that each ſingle Point of the Compaſs is 11 Degrees 15 Minutes.

### *The Uſes of this Circle on the Globe, are,*

1. To determine the Riſing and Setting of the Sun, Moon, or Stars, and to ſhew the Time of it by the help of the Hour-Circle and Index, as ſhall be ſhewed hereafter.

2. To limit the Encreaſe and Decreaſe of the Day and Night: For when the Sun riſes due Eaſt, and ſets Weſt, the Days are equal.

But when he riſeth and ſetteth to the North of the Eaſt and Weſt, the Days are longer than the Nights; as on the contrary, the Nights are longer than the Days, when the Sun riſeth and ſetteth to the Southward of the Eaſt and Weſt Points of the Horizon.

3. To ſhew the *Amplitude* of the Sun, or of any Star, and alſo on what Point of the Compaſs it riſeth and ſetteth.

2. The next Great Circle is the *Meridian*, which is repreſented by the Brazen Frame or Circle in which the Globe hangs and turns: This is divided into four Nineties, or 360 Degrees, beginning at the Equinoctial. 'Tis called the *Meridian*, becauſe when the Sun comes to the South part of this Circle, 'tis then *Meridies*, *Mid-Day*, or *High-Noon*, and then the Sun hath its greateſt Altitude for that Day, which therefore is called the *Meridian Altitude*.

The Plane of this Circle is *perpendicular* to the *Horizon*, and paſſeth thro' the South and North Points thereof, through the *Zenith* and *Nadir*, and through the Poles of the World. In it, each way from the *Equinoctial*, on the *Celeſtial Globe*, is accounted the North or South *Declination* of the Sun or Stars; and on the *Terreſtrial*, the Latitude of a Place North or South; which is all one Quantity with the Elevation or the Heighth of the Pole above the Horizon; becauſe the Diſtance from the *Zenith* to the Horizon being the ſame as that between the *Equinoctial* and the *Poles*, if from each you imagine the Diſtance from the *Pole* to the *Zenith* to be taken away, the Latitude muſt remain equal to the *Pole's* Height.

There are two Points of this Circle, each 90 Degrees from the *Equinoctial*, which are called the

*Poles of the World*; and a Diameter from thence continued through the Centre of either *Globe*, is call'd the *Axis of the Earth*, or *Heavens*, on which they are ſuppoſed to turn round.

Theſe *Meridians* are various, and change according to the *Longitude* of Places; for as ſoon as ever a Man moves but one Degree, or but a Point to the Eaſt or Weſt, he is under a new Meridian: But there is (or ſhould be) one *fixed*, which is call'd the *Firſt Meridian.*

And this on theſe Globes paſſes through *Gratioſa*, one of the *Azores* Iſlands. But the *French* place the Firſt Meridian at *Fero*, one of the *Canary* Iſlands.

The Poles of the Meridian are the Eaſt and Weſt Points of the Horizon.

On the Terreſtrial Globe there are uſually drawn twenty four Meridians

ridians, one through every fifteen Degrees of the Equator, or through every fifteen Degrees of Longitude.

The Uſes of this Circle are (firſt) to ſet the Globe to any particular Latitude, by a proper Elevation of the Pole above the Horizon of that place; and (ſecondly) to ſhew the Sun or Stars Declination, right Aſcenſion, and greateſt Altitude: Of which more below.

3. The next Great Circle is the *Equinoctial*, as it is called on the Celeſtial, and *Equator* on the Terreſtrial Globe. This is a great Circle, whoſe Poles are the Poles of the World; it divides the Globe into two equal Parts or Hemiſpheres, as to North and South; and it paſſeth through the Eaſt and Weſt Points of the Horizon, and at the Meridian is always as much raiſed above the Horizon, as is the Com-

pliment of the Latitude of any particular Place. Whenever the Sun cometh to this Circle, it makes equal Days and Nights all round the Globe ; becauſe it always riſeth then due Eaſt, and ſets due Weſt ; which it doth at no other time of the Year. All Stars alſo, which are under this Circle or which have no Declination, do always riſe due Eaſt, and ſet full Weſt.

All People living under this Circle (which in Geography, or rather by Navigators is called *the Line*) have the Days and Nights conſtantly equal ; and when the Sun is in the Equinoctial, he will be at Noon in their Zenith, or directly over their Heads, and ſo their erect Bodies can caſt no Shadow.

From this Circle, both ways, the Sun or Stars Declination, on the Celeſtial, or Latitude of all Places on the Terreſtrial Globe is accounted on the Meridian : And ſuch leſſer Circles as run through each Degree of Latitude or Declination parallel to the Equinoctial, are called Parallels of Latitude, or Parallels of Declination.

Through every fifteen Degrees of this Equinoctial, the Hour-Circles are drawn at Right Angles to it on the Celeſtial Globe, and all paſs through the Poles of the World, dividing the Equinoctial into twenty four equal Parts.

And the Equator on the Terreſtrial Globe is divided by the Meridian into thirty ſix equal Parts ; which Meridians are equivalent to the Hour-Circles on the other Globe.

4. The *Zodiack* is another great Circle of the Sphere, dividing the Globe into two equal Parts : When the Points of *Aries* and *Libra* are brought to the Horizon, it will cut

*that* and the Equinoctial obliquely, making with the former an Angle equal to the Sun's greateſt Meridian Altitude in any Latitude; and with the Equinoctial, an Angle equal to 23 Degrees and 3 Minutes, which is the Sun's greateſt Declination. This Circle by Aſtronomers is accounted as a kind of broad one, and is like a Belt or Girdle round the Globe: Through the middle of it is drawn a Line call'd the *Ecliptick*, or *Via Solis*, the *Way of the Sun*; becauſe the Sun never deviates from it in its Annual Motion, as the Planets do all more or leſs, whence it hath its Breadth.

This Circle is marked with the Characters of the Twelve Signs, and on it is found out the Sun's Place; which is under what Star or Degree of any of the Twelve Zodiacal Conſtellalions he appears to be at Noon. By this are determined the four Quarters of the Year, according as the Ecliptick is divided, into four equal Parts; and according as the Sun goes on here, he hath more or leſs Declination.

Alſo from this Circle the Latitude of the Planets and fixed Stars is accounted from the Ecliptick towards its Poles.

The Poles of this Circle are twenty three Degrees, thirty Minutes diſtance from the Poles of the World, or of the Equinoctial; and by their Motion round the Poles of the World, are the Polar Circles deſcribed.

In theſe Poles of the Ecliptick all the Circles of Longitude which are drawn through the Zodiac, do determinate, as the *Meridians* and *Hour-Circles* do in the Poles of the World, and as the *Azimuth* or *Vertical Circles* do in the *Zenith* and *Nadir*.

5. If you imagine two great Circles paſſing both through the Poles of the World, and alſo one of them through the *Equinoctial Points*, *Aries* and *Libra*, and the other thro' the *Solſtitial Points*, *Cancer* and *Capricorn.*

Theſe are called the two *Colures*; the one the *Equinoctial*, the other the *Solſtitial Colure* : Theſe will divide the Ecliptick into four equal Parts or Quarters, which are denominated according to the Points, where theſe paſs through, called the four Cardinal Points; and are the firſt Points of *Aries*, *Libra*, *Cancer*, and *Capricorn.*

*Theſe are all the Great Circles.*

6. If you ſuppoſe two Circles drawn Parallel to the Equinoctial, at twenty three Degrees thirty Minutes diſtant from it, one towards

the North, the other towards the South, theſe are called the *Tropicks*, becauſe the Sun appears then to turn backward from his former Courſe; the one the Tropick of *Cancer*, and the other the Tropick of *Capricorn*, becauſe they are under theſe Signs.

7. If two other Circles are ſuppoſed to be drawn through twenty three Degrees thirty Minutes, reckned on the Meridian from the *Polar Points*, theſe are called the *Polar Circles*; the Northern is the Artick, and the Southern the Antartick Circles, becauſe oppoſite to the former.

*Theſe are the Four Leſſer Circles.*

And theſe on the Terreſtrial Globe the Ancients ſuppoſed to divide the Earth into five Zones, *viz.* two *Frigid*, two *Temperate*, and the *Torrid Zone*.

Beſides theſe ten Circles lately deſcribed, which are always drawn on the Globe itſelf, there are ſome other neceſſary Circles to be known, which are barely imaginary, and ſuppoſed only to be drawn upon the Globe. As,

1. *Meridians*, or *Hour-Circles*, which are great Circles meeting all in the Poles of the World, and croſſing the Equinoctial at Right Angles; theſe are ſupplied by the Meridian, Hour-Circle, and Index.

2. *Azimuths*, or *Vertical Circles*, which likewiſe are great Circles of the Sphere, and meet in the Zenith and Nadir, as the Meridians and Hour-Circles do in the Poles: Theſe cut the Horizon at Right Angles, and on theſe is reckned the Sun's Altitude, when he is not on the Meridian. They are

repreſented by the Quadrant of Altitude, which being fixed at the Zenith is moveable about round the Globe through all the Points of the Compaſs.

3. There are alſo *Circles of Longitude* of the Stars and Planets, which are great Circles paſſing through the Poles of the Ecliptick, and in that Line determining the Stars or Planet's Place or Longitude, reckned from the firſt Point of *Aries.*

4. *Almacanters*, or *Parallels of Altitude*, are Circles having their Poles in the Zenith, and are always drawn parallel to the Horizon. Theſe are Leſſer Circles of the Sphere, diminiſhing gradually as they are farther and farther from the Horizon.

In reſpect of the Stars there are alſo ſuppoſed to be *Parallels of La-*

*titude*; which are parallel to the Ecliptick, and have their Poles the ſame with thoſe of that Circle.

4. *Parallels of Declination* of the Sun or Stars; which are leſſer Circles, whoſe Poles are the Poles of the World, and are all drawn parallel to the *Equinoctial*, either North or South; and theſe (when drawn on the Terreſtrial Globe) are called *Parallels of Latitude*.

## *DEFINITIONS.*

1. *Latitude of any Place*, is an Arch of the Meridian of that Place, intercepted between its Zenith and the Equator; and this is the ſame with an Arch of the Meridian intercepted between the Pole and the Horizon; and therefore it is often expreſſed by the Pole's Heighth, or

Elevation of the Pole: The Reaſon of which is, that from the Equator to the Pole, there always being the Diſtance of ninety Degrees, and from the Zenith to the Horizon the ſame Number, and each of theſe ninety Degrees, containing within it the Diſtance between the Zenith and the Pole; that Diſtance therefore being taken away from both, muſt leave the Diſtance from the Zenith to the Equator, equal to the Diſtance between the Pole and the Horizon, or to the Elevation of the Pole above the Horizon.

2. *Latitude of a Star or Planet*, is an Arch of a great Circle reckned on the Quadrant of Altitude laid through the Star and Pole of the Ecliptick, from the Ecliptick towards its Pole.

3. *Longitude of a Place*, is an Arch of the Equator, intercepted between the Meridian of the Place, and the firſt Meridian: Or it is more properly the Difference, either Eaſt or Weſt, between the Meridians of any two Places accounted on the Equator.

4. *Longitude of a Star*, is an Arch of the Ecliptick, accounted from the Beginning of *Aries* to the Place where the Star's Circle of Longitude croſſeth the Ecliptick; ſo that is much the ſame as the Star's Place in the Ecliptick, accounted from the Beginning of *Aries*.

5. *Amplitude of the Sun*, or of a Star, is an Arch of the Horizon intercepted between the true Eaſt or Weſt Points of it, and that Point upon which the Sun or Star riſes or ſets.

6. *Right Aſcenſion of the Sun*, or of a Star, is that part of the Equinoctial reckned from the Beginning of *Aries*, which riſeth or ſetteth with the Sun or Stars in a Right Sphere; but in an Oblique Sphere it is that Part or Degree of the Equinoctial which comes to the Meridian with it, (as before) reckned from the Beginning of *Aries*.

1. *A Right or Direct Sphere* is when the Poles are in the Horizon, and the Equator in the Zenith; the Conſequence of being under ſuch a Poſition of the Heavens as this, (which is the Caſe of thoſe who live directly under the Line) is, that the Inhabitants have no Latitude nor Elevation of the Pole; they can nearly ſee both the Poles of the World. All the Stars in the Heavens do once in twenty four Hours riſe, culminate, and ſet with them;

them ; the Sun always riſes and deſcends at Right Angles with the Horizon, which is the Reaſon they have always equal Day and Night, becauſe the Horizon doth exactly biſſect the Circle of the Sun's Diurnal Revolution.

2. *A Parallel Sphere*, is where the Poles are in the Zenith and Nadir, and the Equinoctial in the Horizon ; which is the Caſe of ſuch Perſons, if any ſuch there be, who live directly under the North or South Poles.

And the Conſequences of ſuch a Poſition are, That the Parallels of the Sun's Declination will alſo be Parallels of his Altitude, or Almacanters to them. The Inhabitants can ſee only ſuch Stars as are on their ſide the Equinoctial ; and they muſt have 6 Months Day, and 6 Months continual Night every Year ; and the Sun can never be higher with them than 23 Degrees 30 Minutes, (which is not ſo high as it with us on *February* 10.)

3. *An Oblique Sphere*, is where the Pole is elevated any Number of Degrees leſs than 90: And conſequently the Axis of the Globe can never be at Right Angles to, nor in the Horizon; and the Equator, and Parallels of Declination, will all cut the Horizon obliquely, from whence it takes its Name.

*Oblique Aſcenſion of the Sun*, or Stars, is that Part or Degree of the Equinoctial reckned from the beginning of *Aries*, which riſes and ſets with them in an oblique Sphere.

*Aſcenſional Difference*, is the Difference between the *Right* and *Oblique Aſcenſion*, when the Leſſer is ſubſtracted from the Greater.

*On*

# *On the Terreſtrial Globe.*

1. A Space upon the Surface of the Earth, reckned between two Parallels to the Equator, wherein the Increaſe of the longeſt Day is a Quarter of an Hour, is by ſome Writers called a *Parallel.*

2. And the Space contained between two ſuch *Parallels* is called a *Climate* : Theſe *Climates* begin at the Equator ; and when we go thence North or South, till the Day become half an Hour longer than it was before, they ſay we are come into the *firſt Climate* ; when the Days are an Hour longer than they are under the Equator, we are come to the *ſecond Climate, &c.* Theſe Climates are accounted in Number 24, reckned each way towards the Poles.

The Inhabitants of the Earth are divided into three ſorts, as to the falling of their Shadows.

1. *Amphiſcii*, who are thoſe which inhabit the Torrid Zone, or live between the Equator and Tropicks, and conſequently have the Sun twice a year in their Zenith; at which time they are *Aſcii*, *i. e.* have no Shadows, the Sun being vertical to them. Theſe have their Shadows caſt to the Southward, when the Sun is in the Northern Signs; and to the Northward, when the Sun is in the Southern Signs, reckned in reſpect of them.

2. *Heteroſcii*, who are thoſe whoſe Shadows fall but one way; as is the Caſe of all ſuch as live between the Tropicks and Polar Circles: For their Shadows at Noon are always

to the Northward in North Latitude, and to the Southward in South Latitude.

3. *Periſcii*, are ſuch Perſons that inhabit thoſe places of the Earth that lie between the Polar Circles and the Poles, and therefore have their Shadows falling all manner of ways, becauſe the Sun at ſome times of the Year goes clear round about them.

The Inhabitants of the Earth, in reſpect of one another, are alſo divided into three ſorts :

1. *Periæci*, who are ſuch as inhabiting the ſame Parallel ( not a great Circle ) are yet directly oppoſite to one another ; the one being Eaſt or Weſt from the other exactly 180 Degrees, which is their Difference of Longitude : Now

theſe have the ſame Latitude and Length of Days and Nights, but exactly at contrary times; for when the Sun riſeth to the one, it ſets to the other.

2. *Antœci*, who are Inhabitants of ſuch places as being under a Semicircle of the ſame *Meridian* do lie at equal Diſtances from the Equator; one towards the North, and the other towards the South.

Now theſe have the ſame Degree of Latitude, but towards contrary Parts, the one North, and the other South; and therefore muſt have the Seaſons of the Year directly at contrary times one to the other.

3. *Antipodes*, who are ſuch as dwell under the ſame Meridian, but in two oppoſite and equidiſtant Parallels, and in the two oppoſite Points of thoſe two Parallels; ſo that they go

Feet againſt Feet, and are diſtant from each other an entire Diameter of the Earth, or 180 Degrees of a Great Circle.

Theſe have the ſame Degree of Latitude, but the one South, the other North, and accounted from the Equator a quite contrary way; and therefore theſe will have all things, as Day and Night, Summer and Winter, directly contrary to one another.

## PROBLEMS.

### 1. *To find the Longitude of any Place.*

Bring the Place to the Braſs Meridian, and the Degrees of that Circle, intercepted between the Place and the Equinoctial, are the Latitude of that place, either North or South.

Then to fit the Globe, ſo that the Wooden Horizon ſhall repreſent the Ho-

Horizon of that Place, elevate the Pole as many Degrees above the Wooden Horizon, as are the Latitude of that Place, and it is done; for then will that Place be in the Zenith.

If after this you rectifie the Globe at any particular Time, you may by the Index know the Time of Sun-riſing and ſetting with the Inhabitants of that Place, and conſequently the preſent Length of their Day and Night, *&c.*

### 2. *To find the Longitude of Places.*

Bring the Places ſeverally to the Braſs Meridian, and then the Number of Degrees of the Equinoctial which are between the Meridians of each place, are their *Difference of Longitude* either Eaſt or Weſt.

But if you reckon it from any Place where a Firſt Meridian is ſuppoſed to be placed, you muſt bring that firſt Meridian to the Brazen one on the Globe; and then turning the Globe about, till the other place come thither alſo, reckon the Number of Degrees of the Equinoctial, intercepted between that firſt Meridian, and the proper one of the place, and that is the Longitude of that place, either Eaſt or Weſt.

### 3. *For the Diſtances of Places on the Terreſtrial Globe.*

See the Problem on the Celeſtial Globe, *for finding the Diſtance between two Stars.*

### 4. *To find what Places of the Earth the Sun is vertical to, at any Time aſſign'd.*

Bring the Sun's Place, found in the Ecliptick on the Terreſtrial Globe, to the Brazen Meridian, and note what Degree of the Meridian it cuts; then by turning the Globe round about, you will ſee what Places of the Earth are in that Parallel of Declination, (for they will all come ſucceſſively to that Degree of the Brazen Meridian) and thoſe are the Places or Parts of the Earth to which the Sun will be vertical that Day; whoſe Inhabitants will then be *Aſcii*, that is, their erect Bodies at Noon will caſt no Shadow.

# PROBLEMS on the *Celeſtial Globe.*

SUppoſe, *May* the 10th, 1701, the Sun's Place to be juſt at the Entrance into the firſt Degree of *Gemini.*

1. *To Rectifie the Globe, or to render it in the General fit to reſolve any Problem; which Rectification therefore is always ſuppoſed to be the firſt thing done. To do which*

Bring the Sun's Place, found in the Ecliptick on the Globe, to the *Meridian,* and the Hour-Index to 12 at Noon.

2. *For the* **Sun's Declination.**

Bring the Sun's Place for that Day (which here and below is ſuppoſed to be given) to the *Meridian*, as before, and then the Degrees of the *Meridian*, reckned from the Equinoctial, either *North* or *South*, are the Sun's *Declination* at Noon, either *North* or *South*, according to the Time of the Year, *viz.* from *March* the 10th to *September* the 12th North, and thence to *March* again South; and the *Declination* for *May* the 10th will be 20 degrees, and about 12 minutes North.

### 3. *For his Amplitude, either riſing or ſetting.*

Bring the Sun's Place to the Horizon, either on the Eaſt or Weſt ſide, and the Degrees of the Horizon, accounted from the Eaſt Point, either North or South, are the *Amplitude* required, *viz.* *May* the 10th, the Sun's *Amplitude* will be 34 degrees to the North of the Eaſt.

And at the ſame time you have, in the outer Circle of Rhumbs, the Point which the Sun riſes or ſets upon, *viz*. N. E. by E. or N. W. by W.

### 4. *For his Right Aſcenſion.*

Bring the Sun's Place to the *Meridian*; and the Number of Degrees intercepted between the Beginning of *Aries*, and the Degree of the Equinoctial which comes to the *Meridian* with the Sun, is the *Right Aſcenſion.*

If you would have it in Time, account every 15 Degrees to be an Hour, and every Degree to be 4 Minutes.

*N. B.* The Reaſon of bringing the Sun's Place to the *Meridian* in this Problem, is, to ſave the Trouble of putting the Globe into the Poſition of a *Right Sphere :* For properly, Right Aſcenſion is that Degree of the Equinoctial which riſes with the Sun in a *Right Sphere.* But ſince the Equator is always at Right Angles to the Meridian, if you bring the Sun's Place thither, it muſt, in the Equinoctial, cut his Right Aſcenſion. Thus in the Inſtance of *May* the 10th. the Sun's Right Aſcenſion will be 59 Degrees, or 4 Hours, wanting 4 Minutes.

5. *For the Oblique Aſcenſion.*

Bring the Sun's Place to the *Horizon* on the Eaſt ſide, and the Number of Degrees intercepted between that Degree of the Equinoctial, which is now come to the *Horizon*, and the Beginning or firſt Point of *Aries*, is the *Oblique Aſcenſion.* Thus *May* the 10th the Sun's *Oblique Aſcenſion* is 30 Degrees, 15 Minutes.

Of theſe two *Aſcenſions*, take the leſſer from the greater, the Remainder will be,

### 6. *The Aſcenſional Difference.*

Which therefore is the Difference in Degrees between the Right and Oblique Aſcenſion, or the Space between the Sun's Riſing and Setting, and the Hour of Six: Wherefore his Aſcenſional Difference turned into Time, will give the Time of the Sun's Riſing or Setting before or after Six. Thus from 59 degrees take 30 degrees 15 minutes, there will remain 18 degrees 45 minutes; the *Aſcenſional Difference* in Degrees; and in Time 1 hour 55 minutes, and ſo much doth the Sun riſe before 6, and ſet after it.

### 7. *For the Sun's Riſing or Setting.*

Bring the Place to the *Horizon*, either Eaſt or Weſt, and the Hour-Index ſhall ſhew the Time either of his Riſing or Setting accordingly; which, *May* the 10th, is 5 minutes after 5 in the Morning, and 5 Minutes before 8 at Night.

The Time of the Sun's Setting, doubled, gives the Length of the Day, which then will be 15 hours 50 minutes; and the Time of his Riſing doubled, gives the Length of the Night; which, *May* 10th, is 8 hours 10 minutes.

### 8. *For the Sun's Meridian Altitude or Depreſſion at Midnight.*

Bring his Place to the *Meridian*, above the Horizon, for his Noon Altitude, which will ſhew the Degree of it, accounted there from the Horizon; which, *May* the 10th, will be 58 degrees, 42 minutes. For his Midnight Depreſſion, below the North Point of the Horizon, you muſt bring the Point in the Ecliptick oppoſite to the Sun's preſent Place, to the South part of the Meridian above the Horizon; and the

Degrees there intercepted between that Point and the Horizon, are his Midnight Depreſſion ; which *May* the 10th will be 18 Deg. 42 Min.

### 9. *For the Sun's Altitude at any Time of the Day given.*

*Rectifie the Globe*, and *fit the Quadrant of Altitude* ; that is, ſcrew the Braſs Quadrant of Altitude to the Zenith ; or in our Latitude, ſcrew it ſo that the graduated Edge cut 51 Deg. 30 Min. on the Meridian, reckned from the Equinoctial.

Then turn about the Globe till the Index ſhew the Time propoſed, and ſtay the Globe there ; after which bring the Quadrant of Altitude to cut the Sun's Place in the Ecliptick, and then that Place or Degree of the Ecliptick, ſhall ſhew the Sun's Altitude on the Quadrant.

Thus *May* the 10th. the Sun's Altitude at 9 a-Clock in the Morning will be 43 Degrees, 30 Minutes.

### 10. *To find the Sun's Hour or Altitude, when he is due Eaſt or Weſt above the Horizon.*

*Rectifie the Globe*, and *fit the Quadrant of Altitude*; then bring the Quadrant to cut the true Eaſt Point, and next turn the Globe about till the Sun's place in the Ecliptick cut the graduated Edge of the Quadrant; for then that place will ſhew the Altitude, and the *Index* the Hour.

Thus *May* the 10th. the Sun will be Eaſt at 5 Minutes paſt 7 in the Morning, and his Altitude then is 26 Degrees.

11. *To*

### 11. *To find the Sun's Altitude, or the Time of the Day, on any Azimuth given, or when the Sun is on any given Point of the Compaſs.*

Set the Quadrant of Altitude to the Azimuth given, then turn the Globe till his place in the Ecliptick touch the graduated Edge of the Quadrant; ſo ſhall *that* place give the Altitude on the Quadrant, and the Hour-Index the Time of the Day.

*Example.* *May* the 10th, the Azimuth being 60 degrees from the South, toward the Eaſt, or the Point of the Compaſs which the Sun is then on, being S. E. by E. and near half a Point more Eaſterly; his Altitude will be (nearly) 46 degrees, and the Hour of the Day a little more than a Quarter paſt 9 in the Morning.

### 12. *To find the Declination and Right Aſcenſion of any Star.*

Bring the Star to the Meridian, and then the Degrees intercepted between the Equinoctial and the Point of the Meridian cut by the Star, are its Declination; and the Meridian cuts and ſhews its Right Aſcenſion on the Equinoctial, accounting it from the Beginning of *Aries*.

### 13. *To find the Longitude and Latitude of any Star.*

Bring the Solſtitial Colure to the Braſs Meridian, and there fix the Globe; then will the Pole of the Ecliptick be juſt under 23 *deg.* 30 *min.* accounted from the Pole above the North Point of the Horizon, and upon the ſame Meridian; there ſcrew the Quadrant of Altitude, and then bring its graduated Edge to the Star aſſigned, and there ſtay it, ſo will the Star cut its proper *Latitude* on the *Quadrant*, reckned from the Ecliptick; and the Quadrant will cut the Ecliptick in the Star's Longitude, or its Diſtance from the firſt Point of *Aries*.

### 14. *To find the Time of any Star's Riſing, Setting, or Culminating,* (i. e.) *being on the Meridian.*

Rectifie the Globe and Hour-Index, and bring the Star to the Eaſt or Weſt part of the Horizon, or to the Brazen Meridian, and the Index will ſhew accordingly the Time of the Star's *Riſing*, *Setting*, and *Culminating*, or of its being on the Meridian.

Thus, *May* the 10th, *Arcturus* will be on the Meridian at about a $\frac{1}{4}$ of an Hour after 10 at Night, *Cor Leonis* will be *ſetting* about 1 in the Morning, and the firſt Star in the Head of *Aries* will be *riſing* about an Hour after.

15. *To*

## 15. *To know at any Time aſſign'd what Stars are riſing or ſetting; what are on the Meridian; and how high they are above the Horizon; and on what Azimuth or Point of the Compaſs they are; by which means the real Stars in the Heaven may eaſily be known by their proper Names, and rightly diſtinguiſhed one from another.*

*Rectifie the Globe*, and *fit the Quadrant of Altitude*, and ſet the Globe, by the means of the Compaſs, due North and South; then turn the Globe and Hour-Index to the Hour of the Night aſſign'd, ſo will the Globe, thus fix'd, repreſent the Face or Appearance of the Heavens for that time.

Whereby you may readily ſee what Stars are in or near the Horizon, what are on or near the Meridian; which are to the North, or which to the South, *&c.* And the Quadrant of Altitude being laid over any particular Star, will ſhew its *Altitude* and *Azimuth*, and on what Point of the Compaſs it is; whereby any Star may be eaſily known; eſpecially if you have a Quadrant, or any ſuch Inſtrument, to take the Altitude of any real Star, ſuppoſed to be known, by the Globe; to ſee whether it agree with that Star which is its Repreſentative on the Globe or not.

### 16. *Given the Sun's Place, and any Star's Altitude, to find the Hour of the Night.*

*Rectifie the Globe*, and *fit the Quadrant*; then move the Globe to and fro, till the Quadrant cut the Star in its given Altitude; for then the Hour-Index will ſhew the Hour of the Night. And thus may the Hour of the Night be known by a Star's *Azimuth*

*Azimuth*, or its *Azimuth* from its *Altitude.*

*Example.* *May* the 10th, the Sun being in the firſt Degree of *Gemini*, I take the Altitude of *Lucida Lyræ*, which I find to be 51 degrees; or I find its *Azimuth* to be two degrees to the Northward of the Eaſt; then bringing to the Quadrant of Altitude, to cut that Star in 51 degrees of *Altitude*, I find the Hour-Index points at 11 a-Clock at Night; as it would alſo have done, had the Star been brought to the *Azimuth* on the Globe.

### 17. *To find the Diſtance between any two Stars.*

If the Stars lie both under the ſame Meridian, bring them to the Brazen Meridian, and the Degrees between them *there* reckned, are their true Diſtance.

Thus *Capella*, or the Star in the Left Shoulder of *Auriga*, and *Rigel*, which is in *Orion*'s Left Thigh, are nearly under the ſame Meridian; and being both brought to the Brazen Meridian of the Globe, their Diſtance there will be found to be 54 degrees.

If they are both in the Equinoctial, or have both the ſame Declination, (*i. e.*) are both in the ſame Parallel; then bring them one after another to the Brazen Meridian, and the Degrees of the Equinoctial intercepted between them, when thus brought to the Meridian ſeverally, are their Diſtance.

If the Stars are neither under the ſame Meridian nor Parallel, then either lay the Quadrant of Altitude from one to the other, (if it will reach) and that will ſhew the Diſtance between them in Degrees: Or elſe take the Diſtance with Compaſſes, and apply that to the Equinoctial, or to the Meridian.

Which Method of Proceeding alſo will ſhew the Diſtance of any two Places on the Terreſtrial Globe in Degrees; and by Multiplication by 70, you will have it in Miles. Wherefore, to find how far any Place on the Globe is from another, you need only take the Diſtance between them on the Globe with a Pair of Compaſſes; and applying the Compaſſes to the Equator, at the Beginning of *Aries*, or at the firſt Meridian, you will there find the Degrees; which multiply by 70, and that will turn it into Miles.

Thus the Diſtance between *London* and *Jamaica* being on the Globe 69 degrees; I multiply that by 70, and it gives me 4830 miles; and ſo far is *Jamaica* diſtant directly from *London*, or in an Ark of a Great Circle.

# THE Deſcription and Uſe OF *COLLINS's* Pocket-Quadrant.

ON the Right Edge from the Centre is a Scale of equal Parts, as uſeful as other ſuch Scales: 'Tis five Inches in Length, and divided into 100 equal Parts.

On the Left Edge is a Line of Tangents continued to two *Radii*, or to 63 degrees 23 minutes, whoſe *Radius* is two Inches and half; and lying by theſe are a Line of Hours and Latitudes for Dialling.

Between theſe two is the Projection ; which is only a quarter of *Stoffler's* *Aſtrolabe* inverted , and fitted for the Latitude of *London*.

Above the Projection , towards the Centre, is put on, in a Quadrant of a Circle, the Sun's Declination. This is eaſily found, being next under the Circles of the Days of the Months: And above this, in four other Quadrants, are the Days of the Months, according to the four Seaſons of the Year.

Below the Projection is the Quadrat and Line of Shadows ; and next below that is the Limb, divided into Degrees and Time.

In the Projection are drawn the two Eclipticks, eaſily known by the Characters of the Signs, and both iſſuing out from the Point of 50 degrees 30 minutes in the Tangent-Line on the Left Edge ; and alſo the two Horizons coming from the ſame Point, and running as the Eclipticks do, one upward, the other downward.

And beſide theſe,all Lines that run from the Right Hand of the Quadrant (reckned from the Centre) towards the Left, are Parallels of Altitude: Theſe begin at the Winter or upper Horizon, and run down to 62 degrees, and run up to 18 degrees; but thoſe that croſs them, and run the other way, are all Azimuths.

Such eminent Stars as are between the two Tropicks, are placed upon the Projection, with Letters to them, referring to their Names on the Back-part, where alſo their Declinations are placed, and their Right Aſcenſions are found in the Limb.

I omit the Deſcription of the Back-part, as being of little uſe; but thoſe which have *Collins*'s *Sector* on a Quadrant, may find a large Account of it there.

Below the Projection is the Quadrat and Line of Shadows, which is only a Line of Natural Tangents to the Arks of the Limb.

All the Parts of the Quadrat are to be eſteem'd as leſs than *Radius*, till you come right over 45 degrees of the Limb, and there you will ſee the Number 1. Then begin the Shadows, and where you ſee the Figures 1, 2, 3, 4, 5, *&c.* you are to underſtand by them ſo many *Radii :* And becauſe 'tis ſometimes of uſe to have theſe repeated, towards the Left Hand in the Quadrat there are great black Points ſet to repreſent them.

# The Uſes of the Quadrant.

## 1. *To Rectifie the Bead.*

LAY the Thread over the Day of the Month, and if it be in the Winter Half-year, bring the Bead to the Upper Ecliptick; but if it be Summer, to the Lower Ecliptick, and then the Quadrant is fitted for uſe. Only obſerve, That if even in Summer you would find the Sun's Hour and Azimuth before or after Six a-Clock in the Morning or Evening, the Bead muſt be rectified to the Winter Ecliptick; and you muſt uſe thoſe Parallels that are above the Winter Horizon in the reverted Tail, as *Collins* calls it. And the String lying thus, ſhews all theſe things at once.

1. The *Sun's Declination* in its proper Circle, next under the Circles of the Months; which from *March* the 10th to *Septemb.* the 11th will be North, but the reſt of the Year South.

2. The *Sun's Place* in the Ecliptick, according to the Seaſon of the Year.

3. His *Right Aſcenſion* in Time, and Degrees in the Limb. Only as to this you muſt remember to account it from the Left Edge towards the Right in the Spring-time, becauſe the Sun is then moving towards the Tropick; but when the Sun is paſt the Tropick, and is coming back again, it muſt be accounted the contrary way, from the Right toward the Left: And beſides this,

| | | | | |
|---|---|---|---|---|
| From | *June* 11, to *Sep.* 13. | you muſt add | 90 | *Degrees* to the Sun's *right Aſcenſion* found in the Limb. |
| | *Sep.* 13, to *Dec.* 11. | | 180 | |
| | *Dec.* 11. to *Mar.* 10. | | 270 | |

### 2. *To obſerve the Sun's Height or Altitude.*

Turn your Back to the Sun, and let his Rays ſhine through the upper Sight on the back Hole in the lower, and then the Thread playing freely in the Limb, will ſhew the Altitude *there*, to be accounted from the Left towards the Right Hand, according to the Directions above given.

### 3. *Having the Sun's Altitude, to find the Hour of the Day, and the Sun's Azimuth.*

Rectifie the Bead, and move the String about till the Bead fall among the Parallels of Altitude in the Projection, on *that* which expreſſes the Altitude obſerved ; and then ſhall the String ſhew the Hour in the Limb to a Minute ; and the Bead will ſhew the Sun's Azimuth alſo at that Time of the Day.

Alſo if the String be laid to any Hour in the Limb, and the Bead rectified, it will ſhew the Sun's Altitude and Azimuth belonging to that Hour, if it be before Six at Night, or after Six in the Morning. But if you would know his Altitude for any time before or after Six in the Summer-time, you muſt rectifie the Bead to the Winter Ecliptick, and then it will fall on the true Parallel of Altitude for that Hour. 'Tis the ſame for the Azimuth.

### 4. *To find the Sun's Amplitude.*

Rectifie the Bead according to the Time of the Year, to its proper Ecliptick; and then bring it to that Horizon it will cut, and the Bead there will ſhew the Amplitude.

In the Summer Half-year you muſt reckon the Amplitude from Eaſt or Weſt, Northward; but in the Winter ſix Months, from thence Southward. The ſame is done for any Star in the Projection, by rectifying the Bead to the Star, and then bringing it to the *Horizon* it will come to touch; and if the Star have North Declination, his Amplitude will be North; if South, the contrary.

### 5. *For the Sun's Riſing or Setting.*

Bring the Bead, rectified to the proper *Horizon*, as before, and the

String in the Limb will cut the Time *there* that the Sun riſeth before or after Six.

*N. B.* This is the Aſcenſional Difference, and may be reckned either in Degrees or Time.

If you double the Sun's Setting, it gives the Length of the Day; if you double the Time, of the Night.

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## The Uſe of the Quadrat and Shadows.

### 1. *To find an Height at one Station.*

LOok through the Sights at the Top of the Tower, Steeple, *&c.* and letting the String play freely in the Limb, obſerve where it reſts when you have a good Sight of the Top of the Height you would meaſure: For if the String fall juſt on Number 1 in the Quadrat, the Heighth of the

Object above the Level of the Eye is juſt equal to the Perpendicular or neareſt Diſtance of the Eye from the Tower. Meaſure then from the Place of the Station to the Tower, and adding to that the Heighth of the Eye above the Ground, the Sum is the Tower's Heighth in Yards, Feet, *&c.*

But if being nearer the Tower you had found the String to fall on 2, 3, 4, of the Shadows towards the Right Hand, *&c.* you are then to conclude the Tower is accordingly, twice, thrice, or four times as high above the Level of the Obſerver's Eye, as is the neareſt Diſtance from him to the Foot of the Tower.

On the contrary, If going farther from the Tower you ſhould find the String to fall on the ſecond, third, or fourth Black Point in the Quadrat toward the Left Hand ; you are then to judge, that the Diſtance between you and the Tower is twice, three times, or four times as great as the Heighth of the Tower above the Eye.

For it will always be thus; As *Radius* is to the Tangent of the Angle of the Altitude at the Place of Obſervation, (*i. e.* to the Parts cut in the Quadrat or Shadows) ſo is the Diſtance between the Station and the Foot of the Object, to the Heighth of the Object above the Eye.

Which Canon worked by the Tables, will readily give the Heighth of any Object, in ſuch Meaſures as the Diſtance between the Station and the Foot of the Object are taken in, let the Angle of Altitude be gained by any Inſtrument whatſoever.

*FINIS.*

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